The Relational Model

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1 Administrivia

Announcements

Assignment

From Last Time

Flask tutorial and exercise.

Outline

1. Relational division
2. Vocabulary
3. Relational model practice

Coming Up

SQL

2 Relational Division

3 Vocabulary

1. If $S = \{a, b\}$ and $T = \{1, 2, 3\}$ then the Cartesian product $S \times T$ has how many ordered pairs?
   A. 5

B. 6
C. 8
D. 9
Write the ordered pairs.

2. If $S = \{a, b\}$ and $T = \{1, 2, 3\}$, which of the following can be a relation for $S \times T$?
A. (a,a), (a,b), (b,a)
B. (a,1), (b,2)
C. (a,2), (2,a)
D. (a,1), (a,3), (b,a)

3. Each row in a relational table is called a(n)
A. attribute
B. domain
C. relation
D. tuple

4. In the relational model, referential integrity is a constraint that places restrictions on the values of
A. references
B. foreign keys
C. superkeys
D. secondary keys

5. In the relational model, the table in which a foreign key appears as the primary key is called its
A. root relation
B. child relation
C. home relation
D. foreign relation

6. In the relational model, in the `SELECT` operation, the theta-condition refers to
A. the selection predicate
B. the selection subject
C. the equality or inequality operator used
D. the null condition

7. Which of the following cannot be done using just a PROJECT operator in the relational model
A. eliminating duplicate values
B. operating on more than one column
C. picking out target rows
D. picking out a vertical subset of a table

8. Which of the following operators allows us to combine pieces of information about an entity that appear on separate relational tables?
A. SELECT
B. PROJECT
C. NATURAL JOIN
D. UNION

9. When converting an E-R model to a relational model, the table for a binary relationship can be replaced by a foreign key provided the relationship is not
   A. one-to-one
   B. one-to-many
   C. many-to-one
   D. many-to-many

10. In converting from an E-R diagram to a relational model, tables are used to represent
    A. entities only
    B. relationships only
    C. both entities and relationships
    D. only entities and attributes

11. If A and B are entity sets with a one-to-one relationship A:B, all of the following are true of the relational model representation for them EXCEPT
    A. the entities A and B may sometimes be combined into a single table with no relationship table needed
    B. the relationship should be represented by placing both primary keys as foreign keys in the other table
    C. the relationship can be represented by placing the primary key of A as a foreign key in the table for B
    D. the relationship can be represented by placing the primary key of B as a foreign key in the table for A

4 Relational Model Practice

1. Consider this instance of a `Student` relation:

sid	*name*	*login*	*age*	*gpa*
50000	Dave	dave@cs	19	3.3
53666	Jones	jones@cs	18	3.4
53688	Smith	smith@ee	18	3.2
53650	Smith	smith@math	19	3.8
53831	Madayan	madayan@music	11	1.8
53832	Guldu	guldu@music	12	2.0

   (a) Give an example of an attribute (or set of attributes) that you can deduce is not a candidate key, based on this instance being legal.
   (b) Is there any example of an attribute (or set of attributes) that you can deduce is a candidate key, based on this instance being legal?

2. Consider this relation schema:

```
Students(sid: string, name: string, login: string,
```

```
        age: integer, gpa: real)

Faculty(fid: string, fname: string, sal: real)

Courses( cid: string, cname: string, credits: integer)

Rooms(rno: integer, address: string, capacity: integer)

Enrolled(sid: string, cid: string, grade: string)

Teaches(fid: string, cid: string)

Meets_In(cid: string, rno: integer, time: string)
```

(a) List all the foreign key constraints among these relations.

(b) Give an example of a (plausible) constraint involving one or more of these relations that is not a primary key or foreign key constraint.

3. Consider the following database instance, which contains information about employees and the projects to which they are assigned:

Emp

empId	lastName
E101	Smith
E105	Jones
E110	Adams
E115	Smith

Assign

empId	projNo	hours
E101	P10	200
E101	P15	300
E105	P10	400
E110	P15	700
E110	P20	350
E115	P10	300
E115	P20	400

Proj		
projNo	projName	budget
P10	Hudson	500000
P15	Columbia	350000
P20	Wabash	350000
P23	Arkansas	600000

Show all the tables (including the intermediate ones) that would be produced by each of the following relational algebra commands:

(a) Symbolically:

$$(\sigma_{\texttt{lastName='Adams'}}(\texttt{Emp})) \bowtie \texttt{Assign}$$

or informally:

```
SELECT Emp WHERE lastName = 'Adams' GIVING T1
T1 JOIN Assign GIVING T2
```

(b) Symbolically:

$$\Pi_{\texttt{empId}}((\sigma_{\texttt{budget}>400000}(\texttt{Proj})) \bowtie \texttt{Assign})$$

or informally:

```
SELECT Proj WHERE budget > 400000 GIVING T1
T1 JOIN Assign GIVING T2
PROJECT T2 OVER empId GIVING T3
```

4. Using these relations:

Relation S, suppliers entities

```
S#  SNAME  STATUS   CITY
----------------------------
S1  Smith  20       London
S2  Jones  10       Paris
S3  Blake  30       Paris
S4  Clark  20       London
S5  Adams  30       Athens
```

Relation P, parts entities

```
P#  PNAME  COLOR  WEIGHT   CITY
----------------------------------
P1  Nut    Red    12.0    London
P2  Bolt   Green  17.0    Paris
P3  Screw  Blue   17.0    Oslo
P4  Screw  Red    14.0    London
P5  Cam    Blue   12.0    Paris
P6  Cog    Red    19.0    London
```

Table SP, suppliers to parts relationship

S#	P#	QTY
S1	P1	300
S1	P2	200
S1	P3	400
S1	P4	200
S1	P5	100
S1	P6	100
S2	P1	300
S2	P2	400
S2	P5	420
S3	P2	200
S4	P2	200
S4	P4	300
S4	P5	400

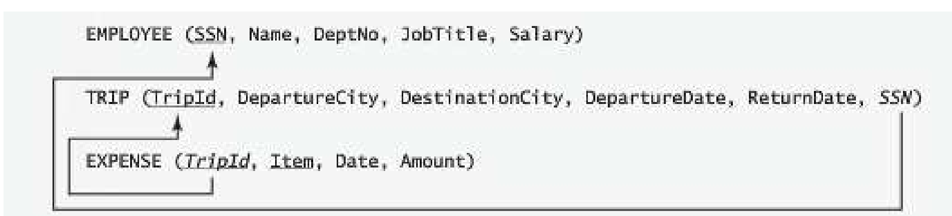
Write the sequence of relational algebra commands to find the names of those suppliers that supply all parts weighing 12.0. Remember, division is defined as

$$\alpha \div \beta = \Pi_{A-B}(\alpha) - \Pi_{A-B}((\Pi_{A-B}(\alpha) \times \beta) - \alpha)$$

where $A - B$ are those attributes of α not in β. Before you start writing relational algebra commands to implement the division, you'll need to write commands to construct α and β.

Show all the tables (including the intermediate ones) that would be produced by each of the relational algebra commands that you write.

5. Consider the following schema for a database that keeps information about business trips and their associated expenses by employees:



Write relational algebra queries for each of the following:

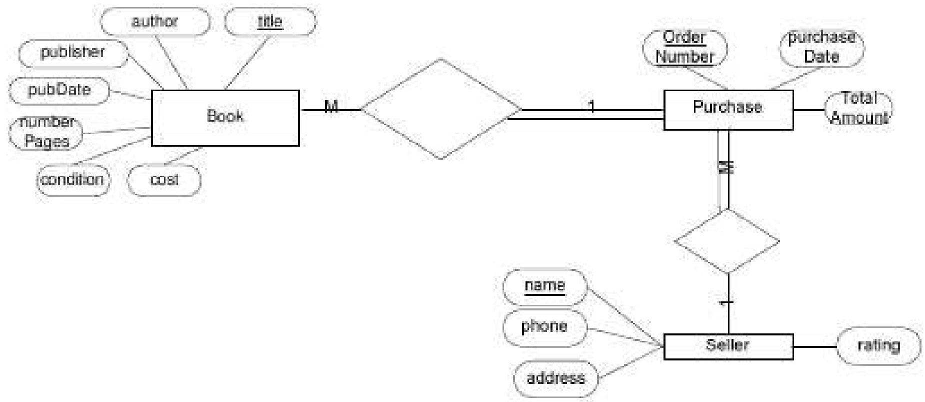
(a) Get a list of all the different destination cities where the employees have taken trips.

(b) Find all the employee information for employees who work in Department 10.

(c) Find the names of all employees who have departed on trips from London.

(d) Find the names of all employees who have any expense item with value `'Entertainment'`.

6. Design a relational database schema for the data about the book collector example that you worked on earlier. Start from this E-R diagram:



7. Design a relational database schema for the data about college students, academic advisors, and clubs that you worked on earlier. Start from this E-R diagram: